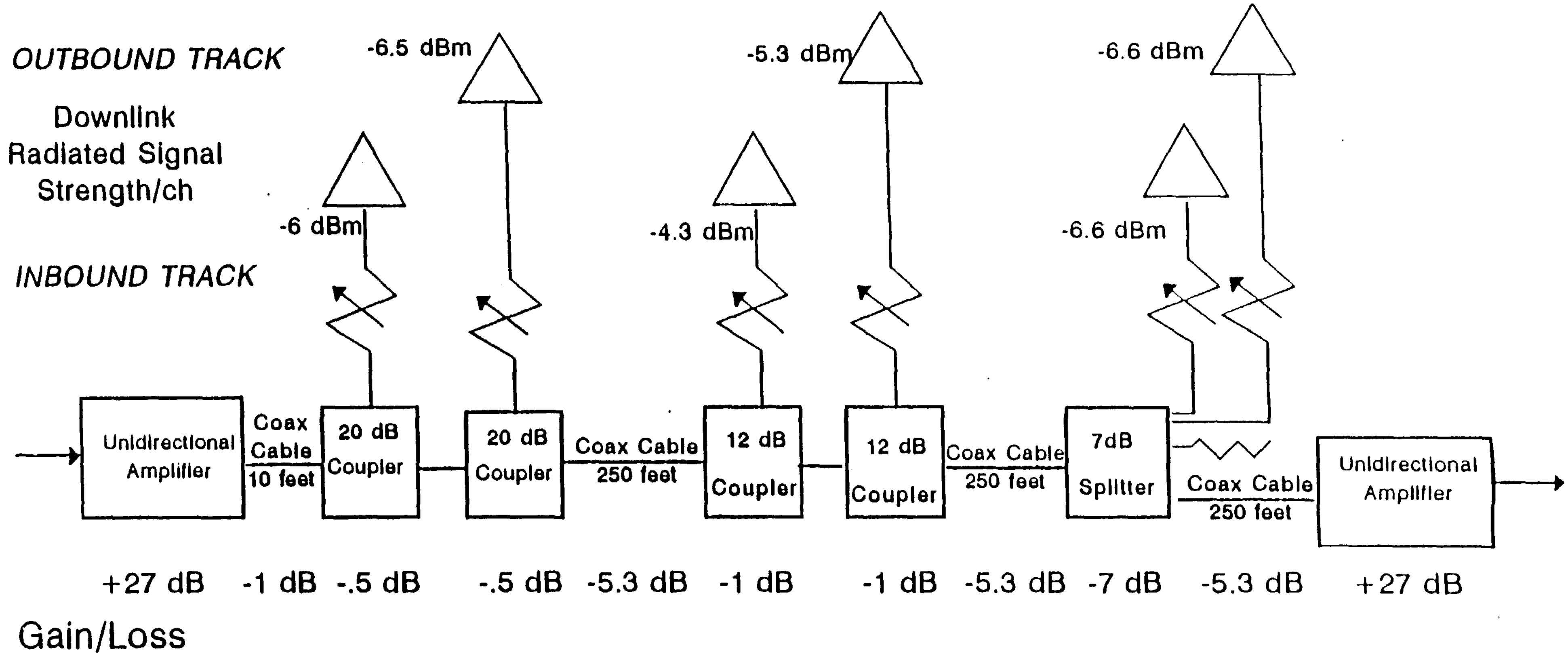
Distributed Antenna System



NOTES:

1. Assumes 1 watt composite power downlink amplifier.
2. 1/2" plenum rated 75 ohm coaxial cable.
3. Maximum number of channels equal 20.
4. Output of each downlink amplifier of +15 dBm/ch
5. Unity gain antennas are used.

DECIBEL
PRODUCTS

Office Cell

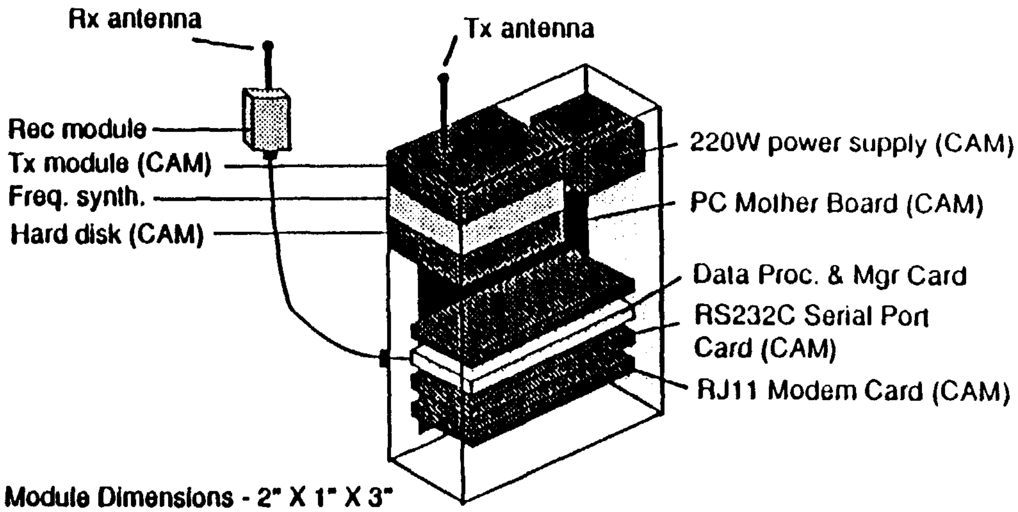
Operating Sequence

1) Receive timing, plus command and control form Polling channel
2) Receive Return Link data from in office STUs (Subscriber Transceiver Unit)
3) Send return link data to system controller over PSTN but change Polling link ID to this office cell ID
4) Receive data over PSTN for transmission on Data channel
5) Transmit data to in-office STUs
6) Receive data from in-office STUs over Data channel

Description of Operational Sequence

The Rec module demodulates the Polling, Data and Return Link channels. The Processor Manager extracts timing plus command and control from the Polling channel, IDs, instructions and ARQ from the Return Link. Office cell sends this office ID plus user ID over the phone line to the system controller. Then, data to be transmitted with transmission instructions are received over the phone line and held in memory until transmission time. Then the computer pulls that file and transmits that file at that assigned time and ARQ procedures. The pager case size Rec. module is linked to the cabinet using phone extension cables with RJ11 jacks on both ends.

Modified PC Mini Tower

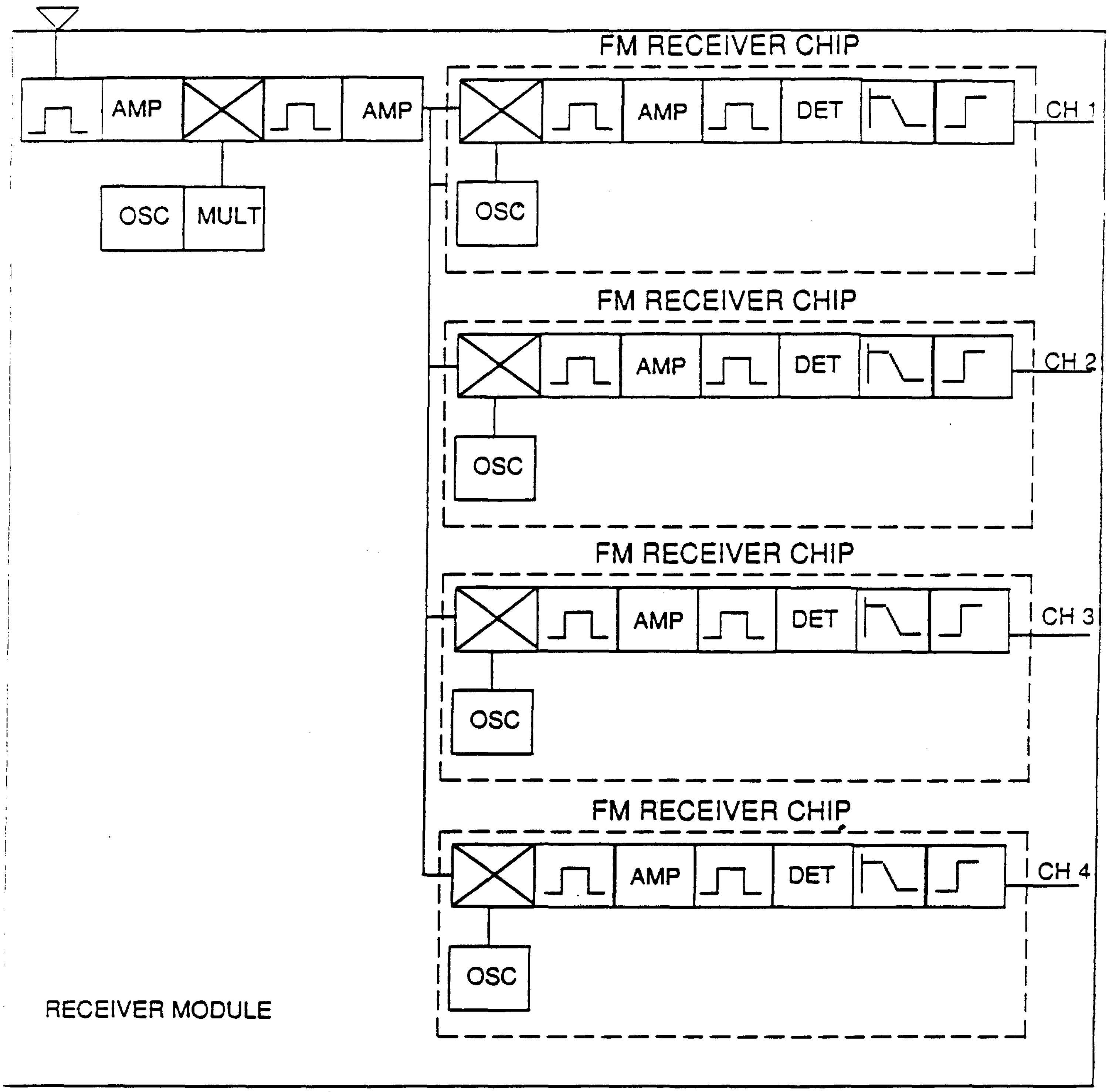


Rec. Module Dimensions - 2" X 1" X 3"
Cabinet Dimensions - 13" X 8" X 16"
(CAM) - Commercial Available Module

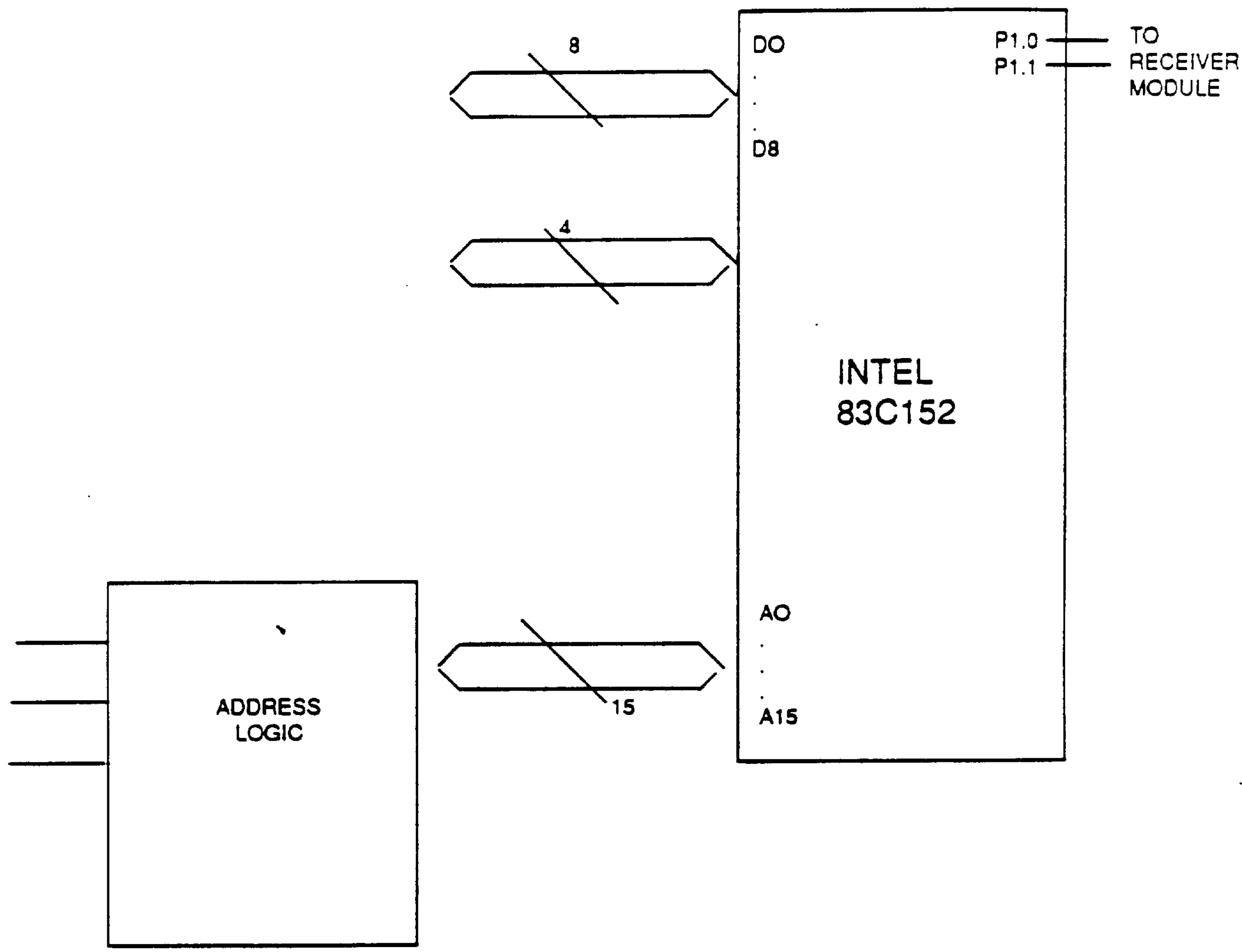
Technical Specifications

Rx Channels	3+	Selectable 8 Fixed 2channels
Bandwidth	25 kHz	Channel bandwidth
Frequency	930.0125 MHz + n25 kHz n = {0,1,2...9}	Channel center frequency n = channel number
RF Power	10w ERP	Effective Radiated Power
Receive Specs	2,400 bps	Match POCSAG 1200
Rec. Module	2" X 1" X 3" (pager case)	RF board of pager
Tx Module	10 watts, one channel	Pager transmitter

Receiver Module
(Functional Block Diagram)



Data Processor and Manager Card



Personal Transceiver Subsystem

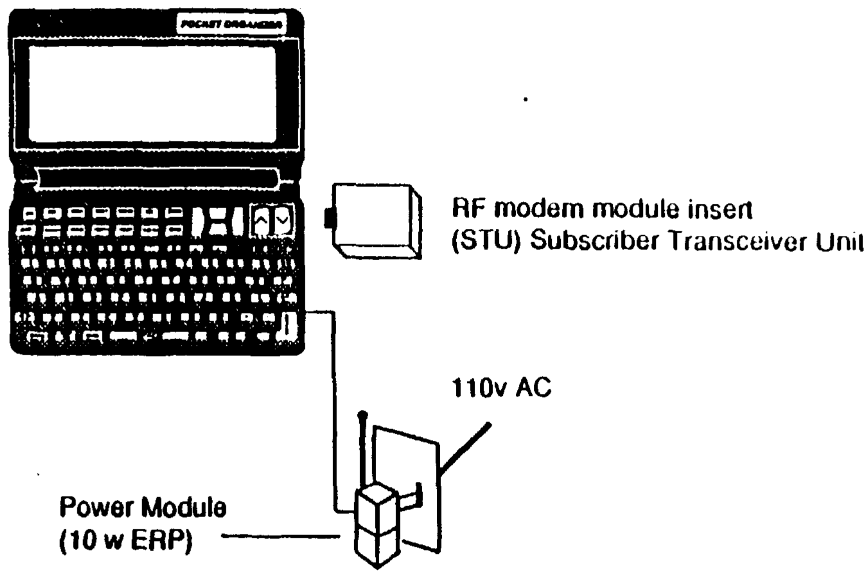
(Subscriber Transceiver Unit + Power Module + End User Product)

Operating Functions

- STU receives Polling and Data channel signals
- STU transmits Return Link channel plus Data channel signals
- Power Module unit boosts RF modem output to 10 watts ERP

Operational Sequence

When paged by the polling channel, the STU receives, decodes and then the Power Module outputs a 10-watt RF signal on the Return Link that tells its ID, best receiving station ID and instructions on delivery of that data. The STU then receives the data on a Data channel and sends back ARQ over the Return Link at 10w. To transmit data back, access is acquired through the Return Link, and data is transmitted over one of the Data channels.



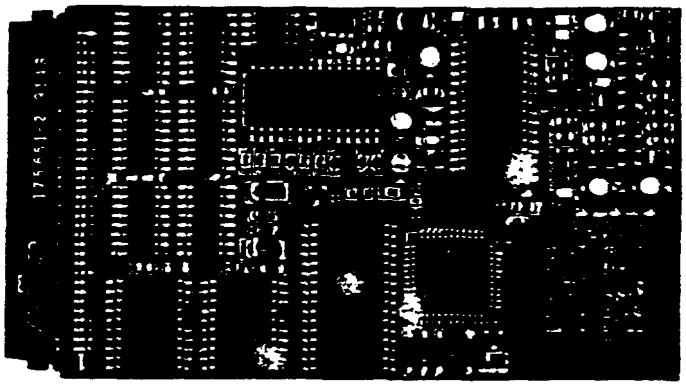
Product Specifications

- RF modem module
  - (1" X 2.5" X 0.25") STU
  - Match pager receiver specs.
  - 100 mw transmitter
- Power Module Unit
  - 10-watt ERP
  - 110 AC wall socket input
  - RF amplifier + power supply
  - charger feedback option

PageMart

PCMCIA "Pager Card" Prototype

(Forerunner of PCMCIA Transceiver Card)



Physical Characteristics

Card Type:	PCMCIA Type II
Interface:	PCMCIA Memory Card or I/O
Antenna:	• Flush mount (battery could be incorporated into external handle; AAA preferred, AA probably too large) • Some manufacturers may require custom design and location. • Contact platform manufacturers on EMI and RFE compatability. This is consistent with other PCMCIA card product manufacturers.
Switch:	Power On-Off
Indicator:	Blinking LED • Message waiting indicator • Low battery indicator when voltage drops to design unit
Display:	None
Lable:	PCMCIA STU release/paragraph 3.1.7 lable

PCMCIA "Pager Card" Prototype
(Continued)

Power Source

Battery:

- 700 hours out of portable (350 hours lower limit)
- Internal see PCMCIA STD release 1.0 paragraph 3.1.6 battery location
- Consider re-chargeable options when card is inserted in platform
- Use portable power source when card is inserted in PCMCIA slot
- Insert and remove with portable power active

Product Features

Data Rate: 2,400 BPS; product evolution should anticipate upgrade to 4,800 or 9,600 BPS as 2nd generation product

Format: POCSAG (2400 BPS)

Address: Minimum of 4 POCSAG addresses. Minimum of 16 addresses including the 2 POCSAG function bits.

Memory: 32K bytes minimum

Internal Clock: Time and date stamp of all received messages or last packet received.

Electrical Requirements/ Commensurate with Motorola Bravo pager
RF Requirements Commensurate with Motorola Bravo pager

Portable Unit
(PDMCIA Card Driver Software)

Display Features: PCMIA pager card should rely on software in the portable unit to manage the information in RAM

- Message waiting indicator
- Number of messages, type of message, time and date stamp of message arrival
- Low battery indicator for PCMCIA card when voltage not within operational limit
- Battery charging indicator (min./max.)
- PCMCIA card in-range indicator

PCMCIA Transceiver Card

Receiver: **See PCMCIA receiver card**

Transmitter:

Power Out:	100 mw to 500 mw
Frequency:	930 MHz
Modulation:	Constant Amplitude
Bandwidth:	FCC masking specification for 25 kHz bandwidth

EXHIBIT B

PAGEMART RESPONSE TO MPR TELTECH

RESPONSE TO MPR TELTECH, LTD.

Prepared for Submission to the
Federal Communications Commission
in Connection with
PageMart, Inc. Request for Pioneer's Preference for Its
Personal Information Messaging Service (PIMS)

ET Docket No. 92-100
PP-40

Prepared by:

Roger Linquist, Chairman
Malcolm Lorang, Vice President
PageMart, Inc.
6688 North Central Expressway, Suite 900
Dallas TX 75206

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<u>Reply Comments to MTel Opposition Petition June 16, 1992</u>

The MTel formal opposition paper to PageMart's request for Pioneers Preference has enclosed technical review material by MPR Teltech, Ltd. that attempt to critique PageMart's PIMS proposal. Each comment by two MPR reviewers will be addressed and will be shown to be without any technical foundation. MPR personnel have either misunderstood, misinterpreted or re-engineered the PIMS system to arrive at their conclusions.

A. Comments on the physical layer aspects of the (PageMart) Petition in Rulemaking.

Accordingly, we shall deal with each point and demonstrate that <u>all</u> of MPR's points are without merit.

MPR concludes 12 cell reuse pattern required

> "It is quite unlikely that a 4-cell reuse pattern could be used in the cellular system design. Calculations indicate that a 12-cell reuse pattern is required."

Both 3 and 4 cell reuse plans confirmed for use in cellular systems. First, MPR concludes, after using Dr. Lee's textbook on cellular system design, that a <u>12</u>-cell reuse plan[1] is needed. This is in direct conflict with the existing cellular telephone industry which has been able to (1) operate under the 7 cell reuse scheme commonly used today, and (2) install as small as a 3 cell reuse "micro-cell" plan with equal to, or better performance than conventional 7 cell plans.

---

1 "From this analysis, the 4 cell reuse strategy proposed by PageMart does not appear to achieve the spectrum efficiencies claimed. A 12 cell reuse strategy using 12 data channels, one polling channel, and one return link channel appear to be the minimum requirement."

Dr. Lee's book, and many others, represent a starting point in cellular system design that doesn't represent (1) current state of the art, or (2) actual experimental data from the massive amount of experimental work done to fine tune theoretical analysis. Specifically, MPR primarily cites the references to Dr. Lee's books and articles that, on the surface, supports their argument and omits the articles that clearly support the four cell reuse plan incorporated in PageMart's design, such as Dr. Lee's article in "Smaller Cells for Greater Performance.[2]" Dr. Lee's paper clearly states that even a 3 cell reuse plan can be designed to be 2 dB superior to a 7 cell reuse design (i.e., 2 dB greater than the standard 18 dB C/I ratio):

Three Cell Reuse

$$\frac{C}{I} = \frac{R^{-\beta}}{\sum_{k=1}^{K_I} D_k^{-\beta}} = 105 \; (=) \quad 20 \text{ dB}$$

The above equation that defines the carrier-to-interference ratio (C/I) is used to estimate cochannel interference from all neighboring cells broadcasting on the same channel at the same time. Normal analog cellular practice is to specify C/I to be 18 dB or higher.

Furthermore, MPR never provides the results of Dr. Lee's digital system design analysis, namely a C/I ratio of 18 dB for an analog voice system which corresponds to a 5 dB reduced requirement for a given digital voice system, resulting in a C/I ratio requirement of 13 dB (in the "Digital Systems" chapter of the same book that MPR uses[3]) for a 4 cell reuse system. Therefore, because

[2] IEEE Communications Magazine, November 1991, Smaller Cells for Greater Performance: Dr. W.C.Y. Lee.
[3] Mobile Cellular Telecommunications System, William C.Y. Lee, McGraw Hill, 1989.

MPR did not cover digital cellular system design, they overlooked the fact that, "The digital unit performance can be reduced by 5 dB to obtain the same performance as an analog unit" (page 428[4]):

Digital Cellular System

> "Swerup and Uddenfeldt compared a narrowband coherent digital modulation with gaussian MSK to an analog FM system. Two 16-kbps voice coders were used. Residual excited linear predicted codes and subband codes were tested. The digital unit performance can be reduced by 5 dB to obtain the same performance as an analog unit. This 5-dB reduction advantage means a large coverage area and a closed frequency-reuse distance for each cell can be served in a cellular system. This is, in turn, an example of high spectral efficiency usage (described in Sec. 13.4). Consider the following calculations.
>
> In a omnidirectional-cell system, assume that $C/I = 13$ dB, i.e.,
>
> $$\frac{C}{I} = \frac{q^4}{6} > 10^{1.3} = 20$$
>
> Solving for q and using Eq. (2.4-5), we obtain
>
> $$q = 3.31 = \sqrt{3K}$$
>
> $$\underline{K = 4 \text{ (frequency-reuse pattern)}}$$
>
> In this case the total number of channels is 333; then
>
> $$m = \frac{333}{4} = 83 \text{ channels/cell}$$
>
> which is higher than the 47 channels per cell for $C/I \geq 18$ dB.

MPR appears to ignore published literature that would provide technical arguments and commercial equipment that implement microcell reuse all the way to 3 cell reuse plans, such as (1) Dr. Lee's recent Microcell system patent 4,932,049 available for commercial use through Decibel Products, its licensed manufacturer (Exhibit 1), Micro Lite products (Exhibit 2), Smart System (Exhibit

[4] Ibid.

3), and (2) Dr. Lee's article on "Efficiency of a New Microcell System.[5]" The article in footnote 5 concludes that not only can a 3 cell reuse pattern be achieved through a very simple design, but that a 4 cell reuse pattern using this technology may be more suitable (Dr. Lee's article on "Efficiency of a New Microcell System", page 3, Exhibit 4):

Four Cell Reuse

> "In edge-excited zone cells, the D_1/R_1 has to be 4.6 in order to maintain the voice quality. Where D_1 is the cochannel zone separation and R_1 is the distance from the zone transmitter to the zone boundary, R_1 is also equal to the cell radius. Then new q ($q = D/R_1$) becomes 3.6 as shown in Fig. 5. Then the frequency reuse factor K becomes
>
> $$K = \frac{(q)^2}{3} = \frac{(3.6)^2}{3} = 4.32 \sim 4 \quad \textbf{(Frequent reuse factor)}$$
>
> which proves that the edge-excited approach can increase the ratio capacity by 7/4 = 1.75 times."
>
> There are situations when all of the zones have to turned on. We call this a non-selective edge-excited zone configuration. In a non-selective edge-excited zone configuration, all of the cells are treated as omni-cells because all zone's sites are transmitting concurrently. In an analog system, the regular center-excited omni-cells require the co-channel interference reduction factor which is equivalent to 1 = D/R = 4.6 as mentioned previously."

Since there is no restriction on cell size, the aforementioned microcell approach is equally suitable for macrocell design.

Another factor that is not considered in MPR's analysis, is antenna pattern design which in many cases can effectively use "down tilt" (accomplished in antenna design to significantly reduce the main lobe energy at the horizon in both omni and sectorized antenna design (see Exhibit 5). Furthermore, factors such as terrain cannot be addressed in any real system design by a terrain propagation

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[5] PacTel Corporation's Pioneer's Request for PCS Technology dated May 4, 1992 (p.62).

factor as used by MPR, but is a fact of life in many systems designs that use natural terrain features (e.g., mountains, canyons, etc.) to even further increase frequency reuse in certain MSA's (e.g., major west coast cities).

It is interesting also that MPR compares C/I ratios specified to be 18 dB or higher (for analog cellular systems) and not 13 dB for digital systems (see Mobile Cellular Telecommunications System by Dr. Lee, page 428) and assert the unsubstantiated figure of 22 dB for binary digital FM systems (no indication by MPR author as to the details of his own work[6]). Moreover, no consideration is given by MPR that address what is currently done in wireless digital data systems to achieve high performance, namely:

- Signal interleaving, for example at the application level versus at the link level
- Forward-Error control (i.e., POCSAG or other protocols).
- Signal diversity through multiple antennas
- Antenna pattern control through down tilt and using narrow beam antennas.

Either collectively or separately, the above signal enhancement approaches are used in many wireless applications.

> MPR: "Normal analog cellular design practice is to specify the C/I to be 18 dB or higher, with this figure requiring the classic seven cell reuse pattern. To achieve a C/I protection ratio of 22 dB[7] requires the use of a 12-cell reuse pattern."

Digital Cellular Systems out performs Analog Cellular Systems on (C/I).

The commercial reality is that even today's data modems that now operate at 9,600 bps and above (IBM's CelluPlan II is contemplating 19.2K bps on conventional AMPs-type cellular systems with C/I = 18 dB) work well in vehicles

---

[6] (Page 8) Normal analog cellular design practice is to specify the C/I to be 18 db or higher, with this figure requiring the classic seven cell reuse pattern. Previous work by the author has found that the 10^{-2} BER capture ratio for binary digital FM in a 25 kHz channel spacing with a 4.0 kHz peak deviation and a data rate of 4,800 bps was on the order of 22 db in the fading channel environment.

[7] Ibid.

with the only typical complaint being dropped connections at hand-off points. Furthermore, it is incorrect to refer to a section in Dr. Lee's book on page 190[8] for analog cellular systems and ignore the relevant equivalent calculations for C/I on digital cellular systems in the same book (page 428).

In summary,

- MPR's own referenced authority, Dr. Lee, has shown that a 3-cell reuse is not only feasible, but it is a commercial reality. Also, a unique 4-cell reuse design is shown to have more design flexibility in Dr. Lee's papers.

- Existing voice analog cellular systems (with C/I = 18) are using commercially available modem equipment to run at rates at or well above 9,600 bps with excellent results except for hand-offs (which PIMS does not require because messages are typically between 10 and 100 seconds).

- MPR unnecessarily limits the scope of their investigation.

  - Many technical papers and books have been published on C/I, signal propagation's losses (including the significant non-linearity of path loses even in the log-log plane of signal versus distance - Dr. Lee assumes a linear log-log extrapolation independent of distance for estimation purposes). Other researchers have done considerable work on transmission path loss[9] and the linear log - log approximation of MPR is only a crude approximation that unduly penalizes short to medium range path loss (see Exhibit 5).

  - Modulation, interleaving and signal diversity techniques for signal enhancement for digital FM systems that support traditional 10^{-2} BER (for paging systems) have been omitted in the MPR discussion.

MPR states that a massive number of receiver sites are needed.

---

[8] MRP statement on page 9: "The use of 120 degree sectoring within each cell of a 4-cell reuse pattern is shown by Dr. Lee (7, p. 190) to yield a co-channel interference ratio of 14 db, which again is unacceptable. This would also require 12 data channels instead of 8. If 60 degree sectoring within each cell of a 4-cell reuse pattern is adopted, a 21 db co-channel interference ratio is obtained. This is a reasonable value for digital RF packet communications.

[9] The PIMS' return link approach is simple: (1) in "free space" (or near free space conditions such as vehicle) approximately 0.1 Watt is sufficient and (2) in buildings up to 10 Watts using a "power module" plugged into line ac voltage, to augment the low power subscriber transceiver is appropriate.

"The PageMart system will need far more than twice the number of dedicated receivers as there are base stations. Calculations indicate that for a 0.1 watt subscriber device, between 25 and 169 dedicated receivers per base station cell site would be required."

PIMS' low power return link in free space and high power "Power Module" approach in buildings is superior to the NWN approach. First, MPR misquotes the PIMS rulemaking document by asserting that (page 10):

"Our understanding of this is that the Effective RF Power (ERP) of the portable device is limited to less than 1.0 Watt, which is consistent with the low powered (0.10 Watt) transceiver that is integrated into a hand-held personal computer product. (p. 8). Yet on p. A13, PageMart proposes To achieve two-way operation in a high insertion loss building, the unit would be coupled with a separate power module, as depicted in Exhibit XII, which would be capable of generating up to 10 Watts as a transmitter. This is also mentioned on page 9. This is inconsistent with their previous statement of limiting the maximum ERP to 1 Watts, and in fact proposes to use the 10 Watts of power in the very area where they wish to use low power to ensure minimum interference with other computer and communication equipment."

PageMart's approach is very straightforward: if the subscriber is outside or riding in a vehicle 100 mw (or up to 1 watt) is adequate return link power to communicate with receiver sites. On the other hand, advanced messaging services are expected to have its major impact on business or "white collar" applications and, therefore, <u>must work especially well</u> in buildings. For inbuilding applications, a "power module" is provided for that mode of operation and could operate at up to 10 watts ERP when plugged into AC line voltage. The "power module" could be configured to operate as either a wired or wireless "repeater" to the subscriber transceiver module.

Thus, when a PIMS subscriber is in a building with even 20 dB or more insertion loss, the return link will function reliably (see table below). The entire theoretical analysis of MPR is aimed at discrediting PIMS free space, 100 mw return link.

However, if MPR would have only stopped to consider, MTel's NWN has even a greater dilemma than PageMart in their return link for acknowledgment.

Available Power for Transmission (Return Link)

System	Location	Total Power	Building Penetration Loss*	Available Power in dBm
PIMS	Outside building	100 mw (20 dBm)	None	**20 dBm**
NWN	Inside building	2 w (33 dBm)	15 dBm	**18 dBm**
Cellular	Inside building	600 mw (27.8 dBm)	15 dBm	12.8 dBm
PIMS	Inside building	10 w (40 dBm)	15 dBm	**25 dBm**

* MPR's assumption

Therefore, if we compare a PIMS subscriber standing outside a high rise office building with a building penetration loss of 15 dB to an NWN subscriber standing inside the building, and a cellular telephone subscriber standing inside. NWN has 2 dBm lower return link power than PIMS, and a cellular subscriber is over 7 dBm lower. Fortunately, their analysis is absolutely disproved by the "real world" experience of portable, hand held cellular phones that work in many high rise office buildings (on the ground floor where the building penetration loss is at least 15 dB).

MPR's analysis is significantly flawed for a number of reasons that could increase power available up to 40 dB:

- The return link must be increased to take into account actual receiver sensitivity (10 dB).

- Return link antenna gain (10 dB).
- No shadowing (8 dB)
- Diversity (+12 dB) – note more than one receiver or antenna.

However, a significant assumption used by MPR in performing their "absolute analysis" prediction of signal power level requires ranging information that many researchers have performed, some of which have measured results that predict distances that deviate by a factor of two or more with regard to short-to-medium distance (see references Bullington (6) and Harley (21)). More importantly, because urban, suburban, with and without significant foliage, short range less than 1Kw, medium range less than 10 kilometers or greater than 10 kilometers, all have an influence on transmission loss prediction because range is highly non-linear (log-log coordinates), one linear log - log equation for 0 to 30 kilometers is only a very crude predictor[10] (see Exhibit 5).

Also, these predictors were not used to evaluate MTel's NWN system return link performance in the NWN technical feasibility report of June 16, 1992.

Cellular telephone systems such as in the case of the non-wireline operator in San Diego (which Communication Industries constructed and PacTel later operated) initiated service with 12 cells (in a difficult terrain environment) and provided reasonable inbuilding performance. As the system, cell-subdivided, to approximately 24 cells, a very good degree of inbuilding performance was achieved. PageMart's San Diego paging services today operate with 12 transmitter base stations and provides very good coverage. A similarly constructed PIMS system in the initial stages would probably have a similar base station deployment with approximately two times that number for receiver sites

[10] Dr. Lee uses 38.4 $\log_{10} d_1$ independently of distance (i.e. short, medium or long distances as Bullington discusses.

(see p. A4, footnote 3 in PageMart's Petition for Rulemaking). Fortunately, cellular telephone users with the millions of hand held portable phones prove every day (and have proven since the mid-80's when cell sites were not as dense as they are today) a 0.6 watt return link can function effectively in the car and even in many buildings.

Consequently, MPR results that indicate...

> "Calculations indicate that for a 0.1 watt subscriber device, between 25 and 169 dedicated receivers per base station cell site would be required"

... is totally incorrect. Based on the aforementioned table of available power levels, PageMart's 10 watt inbuilding power module and 0.1 watt subscriber transceiver module (STM) for free space would be preferred to a two-watt transceiver used for both inbuilding and free space (and cellular's 0.6 watt portable hand held units are physical evidence of this). Furthermore, as experimental evidence is evaluated, STM transmitter power could be increased (even up to 1 watt). Moreover, given the published literature in this field, a literature search shows that the key factor in Dr. Lee's propagation model is the distance equation ($38.4 \log_{10} D_1$). Depending upon the researcher and the objective of the study, one can find the equation to vary widely:

- $38.4 \log_{10} d_1$ - MPR's equation (ref. Okumura, 1968)
- $20 \log_{10} d_1$ - Bullington, 1977 (medium range portion)
- $20 \log_{10} d_1$ - Harley, 1989 (short range)

The range difference between the log-log slope of 38.4 versus 20 can vary substantially and can easily double the range available in calculations under 10 miles. The plain fact is that PageMart's PIMS low power solution is free space (and 10 watts inbuilding) out performs MTel's two-watt only solution. The more appropriate issue, then, is the problem with MTel's transceiver using one power source for all applications. (MTel should then reconsider their 7 watts "die hard" battery solution to be only on a par with PageMart, because they will lose another 3 dB if one compares MTel's 9,600 bps return link to PageMart's 4,800 bps return link solution).

MPR states inbuilding transmission creates serious problems of cochannel and adjacent channel interfaces.

> "The use of 1 Watt and 10 Watt transmitters for in-building transmission creates a serious problem of cochannel and adjacent channel interference for users outside the building and in adjacent building towers. This is based on the false assumption by PageMart that building walls offer high levels of signal attenuation."

PIMS' approach is to contain the inbuilding RF by transmitting only that level of RF needed for reliable inbuilding data transmission. First, the PIMS approach creates the opportunity to realize massive amounts of frequency reuse through low-cost, PC board-type interface and transceiver modules that would be readily interfaced to a standard DOS-type PC (including modem). MPR's own recognition of this is cited in their paper were, if not for the maximum ERP power levels, assumed by MPR (page 16):

> "Although the concept proposed by PageMart is attractive on the surface, there appear to be some fundamental problems in the areas of propagation and building attenuation which have not been fully addressed. The concept proposed would work well if buildings could be considered as perfect RF enclosures, but the vast majority of buildings cannot be treated as such."

PageMart proposes a <u>maximum</u> ERP of 1 watt for inbuilding office cells because there is a great potential difference between offices, both as to location, size and in some cases, an office cell may be used more like a building cell in manufacturing and processing plant environments. It's surprising that MPR would miss the obvious point that each class of installations, such as high rise office buildings (urban areas), versus stand-alone buildings (suburban areas) and the square feet to be covered by the office cell must all be considered so that the lowest acceptable power level is used in any given class of application, because the objective is to contain the RF energy to the extent practical, within the building. Since the PIMS operator(s) would be the source of office and building cell equipment and installation, the inbuilding RF environment will be properly engineered and managed.

Typical power levels from the significant experience of CT-2 installations around the world indicate that ERP levels range from approximately 0.005 to 0.01 watts per channel in most "office environments" (Exhibit 6). PageMart would operate at similar levels.

PIMS broadcasts only non interfering geographical cells during a building/office cell time segment. The same MPR transmission loss equations indicate a calculated value of 0.25 miles distance or two city blocks (and not 0.85 miles) for 0.01 watts ERP which is further reduced by the insertion loss due to other neighboring buildings. The key issue is that a PIMS office cell or building cell does not transmit (1) at maximum ERP unless the nature of the building requires the power, or (2) generate cochannel interference with an overlapping geographical cell, because only non-interfering geographical cells are broadcasted during a building or office cell time segment (see PageMart Rulemaking document p. A22 and Exhibit X). Consequently, geographical cells are not broadcasting in areas where there are building and office cells in order to provide for the massive frequency reuse possible through inbuilding cells. Thus, there is never "an on-street subscriber device" 'that' could still receive signals form this office cell at a distance of 0.85 miles" (page 16, MPR) because a subscriber on the street does not have the possibility of a geographical cell broadcasting in that area on the same time segment.

MPR goes on to conjecture that office cells could interfere with another in an adjacent building, even though "in this case, the RF radiation passes through two building walls (at least)" (page 16, MPR). Using MPR's own conclusion, this is equivalent to 2 X 15 dB = 30 dBm, plus attenuation due to distance, at ground levels (and less as building attenuation decreases with building height) and will not pose any problem with normal inbuilding radiated power of 5 to 10 milliwatts ERP any more than garage door openers and CT-1 cordless phones would create a major problem in suburban areas.

From the standpoint of building cells, the same mistake is made by MPR to use the maximum rated ERP in all building applications without engineering the RF environment in the building. Once again, for purposes of RF containment, building cells will be maintained at as low a power level as practical (typically under 0.1 watts radiating in the mechanical building core) so as not to create unnecessary building-to-building cochannel interference. The output of an inbuilding-distributed antenna system such as that depicted in the PIMS Rulemaking document would require distributed amplifiers to compensate for losses encountered in using a slotted coaxial cable that is hung in the mechanical building core of high rise office buildings. Alternatively, the Decibel Products (DP) solution of a distributed antenna network using 75 ohm coaxial cable with amplifiers would not require high input power at the base station (see Exhibit 7). The DP approach has the added advantage of managing each distributed antenna's output at (1) very low levels of ERP (0.005 to 0.01 watt, and (2) focuses the directional antenna pattern at the interior of the building for even greater RF containment.

Therefore, building cells can be engineered to effectively contain the low levels of RF energy broadcasted. Moreover, there is no cochannel interference when PIMS controls the time of broadcast for building and office cells separate from geographical cells in that local area.

MPR states that PIMS transmitter will jam themselves.

> "There is a great deal of concern about the high power base stations presenting unacceptable levels of adjacent-channel interference in the system coverage area. It appears that they could jam themselves as well as subscriber devices near the base sites."

PIMS base station sites will be engineered to avoid receiver desensitization. First of all, the adjacent channel problem MPR refers to applies more to MTel's NWN system for in-band (930-931 MHz) problem because they will not be able to manage any of the adjacent 50 kHz channel(s) whereas, in PIMS 10-25 kHz channel groups, PageMart and other PIMS system operators can manage the adjacent, in-band, channels (10 channels) to a much higher degree. The out-of-band 929-930 and 931-932 MHz issue has already been addressed by PageMart in the PageNet comments (see PageMart Reply Comments, June 16, 1992, page 19-21). Furthermore, MTel's Reply Comments, June 16, 1992, page 10, footnote 20 also addresses the same adjacent channel interference problem MPR now raises for PageMart. However, the specific advantage MTel claims with NWN that...

> "...the return signal will use a relatively narrowband (25 kHz) channel operating at 9.6K bps that is embedded within the 50 kHz channel. The built-in guardband affords at least 20 dB of additional protection"

...is unlikely.